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ABSTRACT

Ten deaf college freshmen and a comparison group of five hearing students participated in a study of a method to identify long pauses in written composition that have important statistical properties. Subjects first wrote two initial drafts of short stories they had viewed on video tape. Later, they revised and recopied their two originals and one common story account that presented the same content to all subjects. While they were writing under each condition, the duration and location of subjects' pauses were recorded by a computer graphics tablet. Rates of pausing were calculated, and errors identified and classified according to severity. Among findings were that hearing writers were more attentive to errors and more successful in correcting their own errors than deaf writers; and the system used was a reasonable method for identifying serious interruptions in the writing process. Implications for instruction are briefly reviewed. (CL)

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Using the 3-Sigma Limit to Identify Significantly Long Pauses During Composing

by

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Background and Purpose

Pausing has been used repeatedly in composition research as an index of a writer's attention and decision making. The work of Allen(1981), Gould (1980), Martlew(1983), and Matsuhashi(1981) has included measurement of pauses to infer either the focus of a writer's attention or the relative difficulty of various writing tasks. It is assumed that a relatively long pause reflects lack of automaticity in producing or planning text. There have been several strategies used to identify exceptionally long pauses. Allen(1981) used a 5.0 second threshold, and Martlew classified as long pauses all those that were twice the length of the writer's modal pause. Both of these researchers, however, characterized these methods as "arbitrary".

The current paper presents a method for identifying long pauses that have important statistical properties. The paper also explains how the method was tested empirically to determine its capacity to reveal interruptions in composing where they predictably would occur. The method was derived from the work of Shewhart(1931). Shewhart had applied a threshold, called the "3-sigma limit", to aid manufacturers in identifying when and, sometimes, why their production processes were "out of control", generating output that varied erratically and significantly according to some characteristic, such as size, shape, color, or texture of the desired product.

Shewhart noted that there would always be some random variation among items produced, but, so long as the production process was under control, that variation should not exceed a value of the quality characteristic that was more than three standard deviations from the center of the distribution of values for the characteristic. This criterion is referred to as the 3-sigma limit. Theoretically, variation that exceeds the 3-sigma limit indicates the impact of "special causes". These are in contrast to the "constant causes" that affect output that does not vary beyond the 3-sigma limit.

In the present study, Shewhart's procedure was used to identify pauses that were exceptional or "special". Consistent with Shewhart's methods, each writer's distribution of pauses occurring within T-unit boundaries was used as the basis for calculating the 3-sigma pause value for each writer. All pauses that were longer than the writer's median pause plus three sigmas were considered significantly long, "special" pauses.

The capacity of the 3-sigma limit to identify extended decision making was tested by comparing the composing and pausing performance of unskilled hearing writers in college with the pausing during composing of deaf writers in college. There was reason to believe that the hearing writers would exhibit more frequent interruptions, deciding on the correctness of their English grammar. Unskilled hearing writers who have not mastered the conventions of English grammar have been found to experience substantial concern for sentence level correctness. The research of Perl(1979), Pianko (1979), and Shaughnessy(1977) revealed that unskilled writers frequently interrupt their inscription of text in order to make conscious grammatical decisions. Britton's(1980) theory that writers make many linguistic choices at the instant before inscription suggested that many of these serious language related decisions would occur within T-unit boundaries.

The compositions of many deaf writers also show non-mastery of certain conventions of English grammar, but there have been reasons to believe that the deaf are not as chronically or accutely interrupted by decisions related to grammar. Certain errors that the deaf produce may be either the manifestation of a non-standard dialect (Charrow, 1974) or interference from the first-language of the deaf, manual signed communication. Errors could be the reflection of well learned but inaccurate rules resulting from inappropriate

instruction (Wilbur, 1977). Even many highly educated deaf people overlook grammatical errors in their compositions, and the very terms used to describe these errors ("deafisms", Eachus, 1971; "meta-language", Lenneberg, 1967; "distinct rule ordered syntactic structures", Quigley, Power, and Steinkamp, 1977; and "fossilizations", Goldberg, Ford, and Silverman, 1982) suggest that the errors may sometimes result from non-standard language intuitions rather than from repeated wrong decisions which have been made consciously.

The non-standard English of some deaf writers may be produced relatively fluently without the same hyperconcern for correctness that seems to affect unskilled writers with normal hearing. Returning to the purpose of this paper, if the 3-sigma limit is a valid threshold for identifying serious interruptions, then unskilled hearing writers ought to exhibit a greater frequency of Special pauses during composing, because of their increased grammatical decision making.

Methodology

The study was designed so that measured pausing would have the greatest likelihood of reflecting decision making related to grammar instead of discourse goals. First, the sampling frame included subjects who exhibited errors in their writing; these writers reputedly had the greatest risk of concern for grammar. Second, the writing tasks minimized, as much as possible, the competition from the Knowledge and Rhetoric constraints. Third, the analyses of pauses allowed selective focus on pauses occurring at those locations in the text production process where grammatical decision-making would be more likely to occur. Finally, analyses of error correction performance provided an alternate source of data for establishing that there are differences in attention to grammar between the two groups of subjects.

Summary of Methods

Appropriate subjects first wrote two initial drafts of short stories they had viewed on video tape. In later sessions, they revised and recopied three draft story accounts - their two originals and one common story account that presented the same content to all subjects. While they were writing under each condition, the duration and location of subjects' pauses were recorded by a computer graphics tablet. Subjects' texts were divided into T-units, and their rates of pausing were calculated separately within T-units and at T-unit boundaries. Errors were identified and classified according to severity using the system developed by Crandall(1980). Error frequencies were tabulated as were the percentages of errors that subjects corrected in each category. Inter-group comparisons of means related to pausing and error correction constituted the primary analyses.

Subjects

The ten deaf subjects were profoundly, pre-lingually deaf students of normal college age enrolled as freshmen in college; they had no additional handicaps beyond hearing loss. These subjects all attended secondary school in residential programs that used sign language for classroom communication. The deaf subjects all had hearing parents. The comparison group of five hearing subjects were between 18 and 21 years old and attending their first year of college. They were native speakers of English. Their writing samples exhibited errors that spanned categories four through nine in Crandall's classification system.

Writing Task and Conditions

Subjects completed a writing task that was on the Reporting level according to Britton's (1975) paradigm for classifying writing tasks. Subjects wrote descriptions of the people, places, and events of stories that were told

to them on video tape. The subjects worked under three different conditions: Generating, when they wrote original drafts; Revising Self, when they revised and recopied their own drafts; and Revising Other, when they reviewed and revised a standard text written by the investigator and imbedded with representative errors.

Observation Method

The subjects' stationery was positioned on a pressure sensitive graphics tablet that was connected to an Apple II computer. The pressure created by the subject's handwriting at specific locations on the tablet's surface was recorded as a series of Cartesian coordinates (X,Y) in the computer's memory. Meanwhile, the computer's internal time keeping system monitored the passage of time in increments of one tenth of a second and stored the time when each episode of pausing and inscribing started and stopped.

Data Analysis

T-units. Each subject's compositions were segmented into "minimal terminable units" (T-units, Hunt, 1983), which are equivalent to independent clauses with their dependent attachments.

Errors. All errors in texts written during Generating were corrected and classified according to the categories in Crandall's system: Type 9 Mechanical, the least severe, includes spelling and punctuation errors; Type 8 Inflectional Morpheme includes noun and verb inflection errors; Type 7 Bound Derivational includes errors related to prefixes, suffixes, and infixes; Type 6 Free Functor includes pronoun, preposition, and auxiliary verb errors; Type 5 Semantic Contentive Stem includes incorrect use of content words; Type 4 Structural includes word order errors and omission of major constituents; Type 3 Multiple Structural; Type 2 Unconnected English; Type 1 Unrecognizable English, Word Listing, or Naming.

The number of errors per 100 words was calculated for each error category as was the percentage of errors corrected during the revising conditions.

Special Pauses. Significantly long, "Special" pauses that occurred within T-units were identified by applying the following procedure. (1) Each subject's pauses that occurred within T-unit boundaries were ranked according to their duration. (2) The difference between the pause values at the 25th and 75th percentiles was calculated. (3) The result of step #2 was divided by the constant, 1.35 because the 25th/75th difference is equal to 1.35 standard deviation units in a normal distribution. This produced the standard deviation for each subject's estimated distribution of pauses. (4) All pauses within T-units that exceeded a value three times the results of step #3 were judged to be Special since they theoretically fell outside of the subject's estimated distribution of pauses. Note that each subject had a unique threshold for deciding Special pauses. The number of Special pauses per ten words was calculated.

Results

Error Correction

Analyses of error correction performance, which are reported in detail elsewhere (Kelly, In press), indicated that the hearing writes were substantially more attentive than the deaf subjects to errors in their own texts. The hearing writers were more successful in correcting their own errors (under the Revising Self condition) even though the Revising Other results indicated that the two groups had comparable knowledge of grammatical conventions. When inspecting their own texts for errors, the deaf writers apparently did not make repeated wrong decisions to preserve grammar errors that they had attended to; rather it is more likely that they repeatedly failed to detect their

errors. They did not attend to them. This finding serves to validate the deaf/hearing comparison as a reasonable test of the 3-sigma limit as a tool for detecting differences in decision making.

Special Pauses

Table 1 displays the rates of Special Pauses occurring within T-units for the three composing conditions. The calculated t-values and their probabilities are also shown.

TABLE 1

Mean Number of Special Pauses
Per Ten Words
During Three Composing Conditions

Condition	Group	N of Cases	$\bar{x}$	S.D.	t-Value	One Tailed Probability
Generating	Deaf	10	1.0	.20	5.96	.0005
	Hearing	5	1.96	.33		
Revising Self	Deaf	10	1.3	.41	2.4	.03
	Hearing	5	2.1	.70		
Revising Other	Deaf	10	1.07	.37	2.2	.03
	Hearing	5	1.55	.41		

The unskilled hearing subjects exhibited significantly more Special pauses than the deaf writers under all three composing conditions. The greatest difference emerged during the Generating condition,when the hearing subjects made 1.96 Special pauses per ten words, which was almost double the

rate of the deaf subjects. The measurement clearly identified the group with the greatest risk of chronic and acute engagement in grammatical decision making. These findings suggest that the 3-sigma limit is a reasonable method for identifying serious interruptions in the writing process.

Conclusions

This process had the effect of identifying pauses that were exceptionally long and which, therefore, would have potentially substantial impact on Short Term Memory during composing. Also in terms of practical benefits, instead of requiring inspection of every one of hundreds of pauses, this process isolated a relatively small number of pauses to make methodical inspection more manageable. Finally, and most importantly, this process identified pauses with special statistical properties. They were not part of the common, constant cause system. They were theoretically the result of special causes, making them appropriate for individual inspection and qualitative analysis. This procedure may also identify writers who experience serious interruptions in the writing process, revealing the focus of their attention during composing and suggesting instructional intervention.

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